Saltwater Creek Catchment
Flora and Fauna Study
South West Rocks

Prepared for
Kempsey Shire Council Coastal & Estuary Management Committee.

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Table of Contents

1 Background and Introduction

The Saltwater Creek catchment is an intermittently open coastal creek/lagoon system entering the ocean at the western end of front beach at South West Rocks. Saltwater Creek catchment is a discreet coastal catchment located between South West Rocks and the Smoky Cape Range. The catchment area is 8.7 sq Km. Saltwater lagoon is very shallow (0.3-0.7m) and covers an area of approximately 40ha. When the berm is closed water levels in the estuary & lagoon fluctuate in response to rainfall. When the berm is open the estuary and lagoon are tidal.

This report is a supplement to the Saltwater Creek Estuary Processes Study prepared by Manly Hydraulics Laboratory, it outlines the flora and fauna communities and species within the catchment. The study concentrates on those communities and species reliant on surface or near surface watertable regimes. Communities and species not dependent on high water table regimes have been only briefly investigated.

The objectives of the study are:

- Examine all available information for this area;
- Describe and map the main vegetation communities within the study area with particular emphasis on those communities dependent on surface and near surface groundwater regimes;
- Identify those communities most dependant on surface and shallow groundwater systems describing the nature of this dependency. Describe how these relate to a range of water levels governed by beach berm heights at the creek entrance;
- Outline the most distinct and important characteristics and constraints on local distribution of communities dependant on surface and shallow groundwater;
- Identify communities that have local, regional or state conservation significance particularly in the context of particular management requirements;
- Determine the presence or likelihood of rare, endangered, threatened species or communities;
- Comment on particular management required in regard to weeds, fire etc;
- Describe and map the main fauna habitats within the study area with particular emphasis on those communities dependent on surface and near surface groundwater regimes;
- Describe the conservation value of these wetland habitats and identify areas of conservation significance that may require special management attention within the study area, mapping those habitats most critical.
- Determine if there are, or likely to be any rare, endangered, threatened species or communities;
- Describe the main threat to general /specific fauna within the study area with specific reference to a range of water levels determined by beach berm levels at the creek entrance;
- Identify critical times of year for different biota life cycle functions (nesting, breeding etc) supplementing that provided within the “Process Study” by MHL;

- Comment on the role of the natural cycle of creek / lagoon water levels and entrance breakouts on fringing vegetation and associated fauna.

2 Methodology

Study area

The study area is the Saltwater Creek catchment and the northern facing fore dunes of front beach. The catchment boundary has been determined from the 1:25 000 topographic map. The study area is approximately 900 ha in area.

Review of previous studies and species records

Records of flora and fauna (including Rare or Threatened Australian Plants (ROTAP) and Threatened Species Conservation Act (TSC Act) threatened species) known to occur within 10 kilometres of the study area were obtained under license from the National Parks and Wildlife Service Wildlife atlas database. These search results are summarised in tables below. Where habitat for those species is considered to occur in the study area it is marked with an asterisk.

Review Environment Australia's website for possibly occurring threatened ecological communities, threatened species, marine protected species, migratory species and , Ramsar sites, Commonwealth areas and World Heritage Areas. These search results are summarised below.

The following surveys and reports were utalised as background information in the preperation of this report.

Saltwater creek Estuary Processes Study Final Draft Report October 2002.

DLWC cross sectional plans containing flora notes.
Cross-sectional plans of four transects provided by DLWC contain detailed information on the ground surface levels and vegetation community boundaries. These transects were utalised to locate and check mapping boundaries. The location of these transects are shown on map 4.

Department of Urban Affairs and Planning (DUAP) Comprehensive Regional Air Photo Interpretation (CRAFTI) structural and floristic mapping is available digitally. The CRAFTI mapping is broad scale regional mapping. The CRAFTI floristic mapping is considered unsuitable to describe the vegetation communities as it is too broad and does not include the large areas of rural residential land in the east of the catchment. The CRAFTI structural mapping provides an indication of the senescence of the majority of the dry sclerophyll forest communities.

NPWS Coastal Reserve Mapping
The NPWS coastal reserve mapping included Hat Head National Park and the Saltwater Lagoon. This mapping is considered to be detailed and accurate enough to provide the required information for the areas it covers. The classification system used in this mapping provides the basis for the vegetation mapping of the Saltwater Creek catchment.

Vegetation Survey

The Vegetation Study has been principally based on the data obtained from previous studies, this data has been supplemented by a brief survey. The vegetation survey was undertaken over a total period of 8 hours on January 16th and 23rd 2003. Due to time constraints a systematic field study was not undertaken, instead, meandering traverses were undertaken through a comprehensive range of the vegetation communities identified from aerial photo interpretation. The communities dependent on a surface or near surface water table and potential habitat of threatened flora species were targeted during the meanders.

The physical structure, species composition and disturbance history of vegetation communities was recorded, from several floristic plots. A global positioning system (GPS) was used to determine the map coordinates of the plots and any rare or threatened species detected in the study area. A map indicating the vegetation associations contained within the catchment was produced utilising the NPWS coastal mapping for Hat Head NP and 1997 aerial photography.

Fauna Survey

No systematic fauna surveys were conducted.

Survey limitations

As the flora survey was very brief and limited to mid summer, it is probable that many species were not detected.

The flora traverses covered only a small proportion of the study area and many plants would have been undetected as they were either located elsewhere within the study area or without aboveground parts at the time of the survey (some terrestrial orchids such as *Cryptostylis hunteriana*), or with above ground parts not recognisable unless flowering (some grasses, sedges).

3 Results

Rare and Threatened Flora Species

Flora Species of conservation significance found in the study area

No Threatened Species Conservation Act Species or Environmental Protection Biodiversity Conservation Act species have been located within the study area. Suitable habitat exists for all of the species listed in table 1. Suitable habitat for each potentially occurring threatened species is included in the table.

TSC Act Ecological communities.

Graminoid clay heath is an endangered ecological community that occurs in Hat Head NP, however this community does not occur in the study area.

Table 1 - Possibly Occurring Threatened Flora

Name	Common Name	Status	Rotap & Significant	Source	Habitats
Acronychia littoralis	Scented Acronychia	TSC E1 EPBC E	3Eci; 8S	A(10), B,	Wet sclerophyll forest On sand.
Allocasuarina littoralis		TSC E1 EPBC E	2E; 8N	K	Wet heath & swamp sclerophyll forest margins
Chamaesyce psammogeton		TSC E		K	Foredunes and exposed sites on headlands
Cryptostylis hunteriana	Leafless Tongue-orchid	TSC V; EPBC V	3VC-	B	Wet heath
Cynanchum elegans	White-flowered Wax Plant	TSC E1; EPBC E	3ECi	B	Rainforest & wet sclerophyll forest
Marsdenia longiloba	Clear Milkvine	TSC E2; EPBC V	3RC-	B	Rainforest & wet sclerophyll forest
Thesium australe	Austral Toadflax	TSC V; EPBC V	2Vci+	B	Dry sclerophyll forest

Data Sources
A(No); recorded on the NSW NPWS atlas (Number of records)
B; Environment Australia Website possibly occurring Species
K; additional species considered by Kendall & Kendall as a possibly occurring

Vegetation Communities

The vegetation of the Saltwater Creek catchment is complex and diverse, with twenty four naturally occurring vegetation communities resulting from variations in exposure to salt

winds, fire, drainage, and soil parent materials. A further eight non-vegetated or artificial communities were also located within the study area.

Mapped Vegetation communities

Rainforest
0503 Lophostemon confertus Littoral rainforest

Wet Sclerophyll Forest
3002/3504 Lophostemon confertus – Eucalyptus pilularis

Dry Sclerophyll Forest & Woodland
3504 Eucalyptus pilularis
3516 Eucalyptus signata
3515 Eucalyptus planchoniana
3529 Eucalyptus pilularis – C intermedia
3553 Allocasuarina littoralis – Jacksonia scoparia/Banksia integrifolia ssp integrifolia
3554 Eucalyptus pilularis – E signata
3550 Eucalyptus pilularis – E gummifera/ E planchoniana

Swamp Sclerophyll Forest
4002 Eucalyptus robusta
4003 Melaleuca quinquenervia
4099 Casuarina glauca - Melaleuca quinquenervia

Shrubland Formation
5007 Eucalyptus pilularis/ E planchonana/ E gummifera
5401 undetermined dry sclerophyll shrubland
5408 Acacia sophorae
5503 Banksia ericifolia var. macrantha

Heathland Formation
Wet Heath
6000/6400 undetermined wet heath/ sedgeland
6002 Banksia oblongifolia Leptospernum liversidgei Lepyrodia interupta Sprengelia sprengelioides Xanthorrhoea fulva.
6003 Leptospernum juniperiumTussock Grassland

Sod Grassland Formation
6202 Spinifex sericeus

Sedgeland Formation
6400 Undetermined sedgeland
6402 Baumea juncea
6403 Leptocarpus tenax Restio pallens Schoenus brevifolius

Rushland Formation
6502 Juncus krausii ssp australiensis

Complex Map Units
9010 Foredune complex

Miscelanous Map Units
9102 Beach – mobile sand
9104 open water
9202 Partly cleared
9203 Cleared
9206 Picnic - Camping Area
9209 Urban development
9212 Introduced Trees
9213 Introduced shrubs

Vegetation Community Descriptions

0503 Lophostemon confertus Littoral Rainforest
This community occurs on exposed headlands and hillsides in Hat Head NP. Its occurrence in the catchment is limited to one location on the upper slope of the Smokey Cape Range, within Hat Head National Park.

This community is a simple nothophyll low to tall closed forest in which Lophostemon confertus dominates the upper strata. The understorey is sparse and contains species such as *Cassine australis, Eupomatia laurina, Rhodamnia rubescens* and *Synoum glandulosum.* Vines include *Cissus hypoglauca* , *Derris involuta,*

Local Conservation Status
This community occurs in 4 locations within Hat Head National Park and covers a total of 27ha, approximately 1ha is reserved within the Saltwater creek catchment.

Regional conservation status.
All littoral rainforest associations are considered to be poorly conserved regionally, occurances outside national parks are protected by SEPP26.

3002/3504 Lophostemon confertus – Eucalyptus pilularis Wet Sclerophyll Forest
This community is a composite community in which *Lophostemon confertus* and *E pilularis* dominate, common associates include *Corymbia intermedia, E tereticornis, E robusta, Melaleuca quinquenervia*. The lower strata is dominated by mesic shrubs and herbs.

Occurs in the protected gullies of the Smokey Cape Range this community is reserved in 23 locations within Hat Head National Park covering a total of 52ha.

3504 Eucalyptus pilularis Dry Sclerophyll Forest
Eucalyptus pilularis is the dominant upper strata species, the subdominants vary considerably but include *Corymbia intermedia, Eucalyptus microcorys, E siderophloia, Syncarpia glomulifera*. Mid strata species include *Allocasuarina littoralis, Jacksonia scoparia* and *Persoonia stradbrokensis*. Lower strata species include *Themeda australis, Lomandra longifolia* and *Pteridium esculentum*.

This community is widespread within Hat Head National Park where it covers a total of 285ha

3516 Eucalyptus signata Dry Sclerophyll Forest
Eucalyptus signata dominates this association, subdominants include *Corymbia intermedia* or *C gummifera, E planchoniana* and *E microcorys*. Mid strata species include *Persoonia*

stradbrokensis Allocasuarina littoralis, Banksia sp. And *Dodonaea triquetra*. Lower strata species include *Themeda australis, Entolasia stricta, Lomandra longifolia* and *Restio tetraphyllus.*

This community occurs in 3 locations within Hat Head National Park covering a total of 10ha

3515 Eucalyptus planchoniana Dry Sclerophyll Forest
Eucalyptus planchoniana dominates this community. Mid strata species include *Acacia ulicifolia, Dilwynia retorta, Dodonaea triquetra,* and *Melaleuca nodosa*. Lower strata species include *Imperata cylindrica, Lomandra longifolia,* and *Themeda australis*

This community occurs in 3 locations within Hat Head National Park where it covers a total of 5ha

3529 Eucalyptus pilularis – C intermedia Dry Sclerophyll Forest

This community occurs in 22 locations within Hat Head National Park where it covers a total of 195ha

3553 Allocasuarina littoralis – Jacksonia scoparia/Banksia integrifolia ssp integrifolia Dry Sclerophyll Forest
This community occurs in 12 locations within Hat Head National Park where it covers a total of 55ha

3550 Eucalyptus pilularis – E gummifera/ E planchoniana Dry Sclerophyll Forest
This community occurs in 34 locations within Hat Head National Park where it covers a total of 991ha

3554 Eucalyptus pilularis – E signata Dry Sclerophyll Forest
This community occurs in 8 locations within Hat Head National Park where it covers a total of 14ha

4002 Eucalyptus robusta Swamp Sclerophyll Forest
Dominated by *Eucalyptus robusta* with *Melaleuca quinquenervia* as an associate Understorey species include *Banksia robur, Gahnia sieberiana, Blechnum indicum* and *Gleichenia dicarpa*.

2.6ha of this community occurs to the west of Saltwater lagoon, this community occurs in 12 locations within Hat Head National Park and covers a total of 32ha, none is reserved within the Saltwater creek catchment.

4003 Melaleuca quinquenervia Swamp Sclerophyll Forest
Melaleuca quinquenervia dominates the upper strata, *Casuarina glauca* and *E robusta* may be minor associates. A mid strata is generally sparse but contains mesic species including *Lantana camara, Synoum glandulosum* and *Glochidinon ferdandii*. The lower strata is influenced by soils and moisture varying considerably, it includes *Baumea juncea, B rubiginosa, Carex appressa, Gahnia sp, Viola hederaceae,* and *Imperata cylindrica*.

This community occurs in 133 locations within Hat Head National Park and covers a total of 929ha, 31ha is reserved within the Saltwater creek catchment.

4099 Casuarina glauca - Melaleuca quinquenervia Swamp Sclerophyll Forest
Casuarina glauca - Melaleuca quinquenervia Swamp Sclerophyll Forest is a mixed community containing the attributes of 4002 and 4003 described above.

This community occurs in 14 locations within Hat Head National Park and covers a total of 136ha, none is reserved within the Saltwater creek catchment

5007 Eucalyptus pilularis/ E planchonana/ E gummifera
Eucalyptus pilularis dominates with either *E planchoniana* and *Corymbia gummifera*. The mid strata contains *Banksia aemula, Boronia pinnata* and *Leptospermum trinervium* The lower strata contains *Xanthorrhoea johnstonii, Caustis recurvata* and *Lomandra longifolia.*

This community occurs in 31 locations within Hat Head National Park and covers a total of 427ha, 5ha is reserved within the Saltwater creek catchment.

5401 Undetermined Dry Sclerophyll Shrubland

This community was not mapped in Hat Head National Park

5408 Acacia sophorae Dry Sclerophyll Shrubland
Acacia sophorae dominates this community, associates include Bitou (*Chrysanthemoides monilifera* ssp. *rotundata*), *Hibbertia scandens, Ipomoea brasiliensis, Stephania japonica* and *Paspalum urvillei* (Vasey Grass).

This community occurs in 1 location within Hat Head National Park and covers a total of 6ha, 6ha is reserved within the Saltwater creek catchment

5503 Banksia ericifolia var. macrantha Shrubland
Banksia ericifolia var. *macrantha* dominates this association, *Allocasuarina littoralis, Isopogon anemonifolius, Jacksonia scoparia, Kunzea capitata, Banksia integrifolia, Callistemon pachyphyllus* and *Baumea rubiginosa* are common associates.

This community occurs in 12 locations within Hat Head National Park and covers a total of 23ha, none is reserved within the Saltwater creek catchment

6000/6400 Undetermined Wet Heath/ Sedgeland
This wet heath / sedge land community has been applied to the area that has been recently slashed and or cleared. Regeneration by native species is in the early stages and although a moderate diversity of wet heath and sedge species are present and the area is expected to return to a wet heath - sedgeland complex it is difficult to determine the precise associations present.

6002 Banksia oblongifolia Leptospernum liversidgei Lepyrodia interupta Sprengelia sprengelioides Xanthorrhoea fulva Wet Heath
Banksia oblongifolia Leptospernum liversidgei Lepyrodia interupta Sprengelia sprengelioides Xanthorrhoea fulva association is floristically diverse dominated by some of the above species, associates include *Beackea linifolia, Empodisma minus, Epacris microphylla* and *Gahnia sieberiana*.

This community occurs in 38 locations within Hat Head National Park and covers a total of 394ha, none is reserved within the Saltwater creek catchment

6003 Leptospernum juniperium Wet Heath
Leptospernum juniperium dominates although L liversidgei may be a minor associate. *Empodisma minus, Restio tetraphyllus, Gahnia sieberiana Blechnum indicum* and *Xyris operculata* are common.

This community is not recorded from Hat Head National Park but is recorded as a composite association with 6403 it occurs in 2 locations within Hat Head National Park and covers a total of 60ha, none is reserved within the Saltwater creek catchment.

6202 Spinifex sericeus Sod Grassland
Spinifex sericeus dominates this association, minor associates include *Ipomoea brasiliensis*, and *Acacia sophorae*.

This community occurs in 1 location within Hat Head National Park and covers a total of 3ha, this occurance is within the study area.

6400 Undetermined Sedgeland
This community was observed from a distance and although it was clearly sedgeland the association was not determined.

Hat Head national Park conserves 287 ha of sedge land.

6402 Baumea juncea Sedgeland
Baumea juncea dominates this association, *Phragmites australis* is sometimes a common associate.

This community occurs in 6 locations within Hat Head National Park and covers a total of 71ha, 20ha is reserved within the Saltwater creek catchment.

6403 Leptocarpus tenax Restio pallens Schoenus brevifolius Sedgeland
A floristically variable association where *Leptocarpus tenax, Restio pallens* and/or *Schoenus brevifolius* are dominant, however *Baumea teretifolia, Chorizandra sphaerocephala, Xyris operculata* and *Callistemon pachyphyllus* may also be common.

This community occurs in 28 locations within Hat Head National Park and covers a total of 135ha, none is reserved within the Saltwater creek catchment

6502 Juncus krausii ssp australiensis Rushland (saltmarsh)
This association is dominated by *Juncus kraussii* (marine rush). With *Sporobolus virginicus* marine couch, *Avicennia marina* grey mangrove and *Sarcocornia quinqueflora* uncommon associates. Some small areas of mangrove, too small to map separately were included in this association. Saltmarsh communities are dependent on periodic inundation by saline or brackish water. The boundary between the saltmarsh and the dune vegetation can be indistinct, intertidal wetlands are areas with low relief and small vertical change in the water height may have extensive horizontal impact, a broad zone of uncertainty of species distribution or ecotone will result.

This community is not recorded in Hat Head National Park.

9010 Foredune Complex
This is a complex community confined to the foredunes.

This community occurs in 30 locations within Hat Head National Park and covers a total of 137ha, 31ha is reserved within the study area.

Regional Conservation Status of Vegetation Communities

The regional conservation status of the natural vegetation communities within the study area have been assessed using the following regional studies.

Griffiths S. (1993). Conservation Status of Coastal Plant Communities in Northern New South Wales a Review (Draft Report).

Griffiths uses the detailed mapping of the following coastal reserves, Broadwater, Yuragir, Hat Head, Crowdy Bay National Parks (NPs), and Kattang Nature Reserve (NR) to classify coastal plant communities to association level. Griffiths then assesses the reservation status of each of the associations by looking at their occurrence in Tyagera NR, Broadwater NP, Bundjalung NP, Yuragir NP, Crowdy Bay NP, Kattang NR, Hat Head NP, Limeburners Creek NR, and Crowdy Bay NP, Booti Booti NP, Myall Lakes NP and Tomaree NP.

Griffiths study provided the framework for the vegetation classification used for this project.

Resource & Conservation Division, (RACD) Dept of Urban Affairs & Planning (1999). Forest Ecosystem Classification & Mapping for Lower North East CRA Regions.
This study analysed plot data to derive a forest ecosystem classification system and it provides the most current benchmark for the distribution and conservation of forest ecosystems in the North-eastern NSW. The system was developed from the analysis of 4,730 vegetation plots and various vegetation mapping projects. Reservation targets have been set for each forest ecosystem, rare ecosystems have a reservation target of 100%, vulnerable ecosystems have a reservation target of 60% and other ecosystems have a reservation target of 15%, of their current areal extent.

Table 2: Regional Conservation Status of Vegetation Communities

Association No	Association name	Ha in Hat Head	Griffiths	CRA Conservation targets
0503	Lophostemon confertus LRF	27	Inadequately conserved	FE168 Rare 100% target – not achieved Protected under SEPP26
3002/3504	Lophostemon confertus – Eucalyptus pilularis WSF	52	Inadequately conserved	FE106/FE34 15% target –not achieved
3504	Eucalyptus pilularis DSF	285		FE34 15% target –not achieved

Association No	Association name	Ha in Hat Head	Griffiths	CRA Conservation targets
3516	Eucalyptus signata DSF	10		FE65 15% target - achieved
3515	Eucalyptus planchoniana DSF	5		FE20 Rare 100% target –not achieved
3529	Eucalyptus pilularis – C intermedia DSF	195		FE23 15% target –not achieved
3550	Eucalyptus pilularis – E gummifera/ E planchoniana DSF	991		FE27 15% target - achieved
3553	Allocasuarina littoralis – Jacksonia scoparia/Banksia integrifolia DSF	55	Inadequately conserved	FE18 Rare 100% conservation target- not achieved
3554	Eucalyptus pilularis – E signata DSF	14		FE27/FE65 15% target -achieved
4002	Eucalyptus robusta SSF	32	Inadequately conserved	FE142 15% target –not achieved
4003	Melaleuca quinquenervia SSF	929		FE112 Vulnerable 60% conservation target –achieved Some areas have SEPP14 protection
4099	Casuarina glauca - Melaleuca quinquenervia SSF	136		FE112/143 Vulnerable 60% conservation target – not achieved Some areas have SEPP14 protection
5007	Eucalyptus pilularis/ E planchonana/ E gummifera shrubland	247		FE169 Vulnerable 60% conservation target –achieved
5401	Undetermined Heath			FE64 Vulnerable 60% conservation target- not achieved
5408	Acacia sophorae shrubland	6		FE169 Vulnerable 60% conservation target– achieved
5503	Banksia ericifolia shrubland	23	Inadequately conserved (part of range)	FE169 Vulnerable 60% conservation target– achieved
6000/6400	wet heath/ sedgeland		unknown	FE64/141 Vulnerable/Rare

Association No	Association name	Ha in Hat Head	Griffiths	CRA Conservation targets
				60%/100% conservation target– not achieved
6002	B oblongifolia L liversidgei Lepyrodia interupta Sprengelia sprengelioides X fulva heath	394		FE64 Vulnerable 60% conservation target- not achieved
6003	Leptospernum juniperinum heath	0		FE64 Vulnerable 60% conservation target- not achieved
6202	Spinifex sericeus tussock grassland	3		FE96 Rare 100% conservation target- not achieved
6400	Undetermined sedgeland		unknown	FE141 Rare 100% conservation target- not achieved Some areas have SEPP14 protection
6402	Baumea juncea sedgeland	71	Inadequately conserved	FE141 Rare 100% conservation target - not achieved Some areas have SEPP14 protection
6403	Leptocarpus tenax Restio pallens Schoenus brevifolius sedgeland	135		FE141 Rare 100% conservation target - not achieved Some areas have SEPP14 protection
6502	Juncus krausii rushland	0	Inadequately conserved	FE141 Rare 100% conservation target- not achieved Some areas have SEPP14 protection
9010	Foredune complex	137		FE5/FE76 Vulnerable/rare 60%/100% conservation target - not achieved

Vegetation communities dependant on surface and shallow groundwater systems.

The following communities are dependant on surface and/or shallow groundwater systems, and are considered as wetland communities in an ecological sense. Some of these communities are protected under the Coastal Wetlands Policy SEPP14 (* indicates SEPP14 Wetland community), those communities not included in the SEPP14 definition are none-the less an integral part of the whole wetland system.

The nature of each communities dependency is indicated in table 3, and further discussed below.

Table: 3 Wetland Communities

Association No	Association name	Nature of dependency
4002	Eucalyptus robusta SSF	High watertable
4003 *	Melaleuca quinquenervia SSF	Periodic innundation & high watertable
4099 *	Casuarina glauca - Melaleuca quinquenervia SSF	Periodic innundation & high watertable
5401	Undetermined Heath	Nutrient balance & periodically high watertable
5503	Banksia ericifolia shrubland	Nutrient balance & periodically high watertable
5504	Leptospernum juniperinum shrubland	Nutrient balance & periodically high watertable
6000/6400	wet heath/ sedgeland	Nutrient balance, periodically high watertable & periodic innundation
6002	B oblongifolia L liversidgei Lepyrodia interupta Sprengelia sprengelioides X fulva heath	Nutrient balance & periodically high watertable
6003	Leptospernum juniperinum heath	Nutrient balance & periodically high watertable
6400 *	Undetermined sedgeland	Periodic innundation & high watertable
6402 *	Baumea juncea sedgeland	Periodic innundation & high watertable
6403 *	Leptocarpus tenax Restio pallens Schoenus brevifolius sedgeland	Periodic innundation & high watertable
6502 *	Juncus krausii rushland	Tidal inundation & high watertable

* denotes SEPP14 wetland community.

Nutrient Ballance

Nutrient Balance is a critical factor limiting the distribution of wet heath. Australian heaths are finely tuned to the efficient and conservative use of nutrient and water. The key factor

delineating the distribution and boundaries of heath are low availability of nitrogen and phosphorus and the seasonal availability of water.

The sensitivity of heath is illustrated by the following example. The long term survival of heath is threatened by small increases in P particularly in those areas adjoining urban development.

The following pollutants contain sufficient P to kill a square metre of heath:

- ½ daily output of faeces from a single dog;
- 3 days output of urine from a single dog; or,
- 1 days output of urine from a single human. (Handreck 1997)

Stormwater and Groundwater from urban areas are likely to carry sufficient P loads to kill or damage the sensitive heath communities.

The phosphorus and nitrogen loads infiltrating the groundwater from a range of activities associated with urban development will influence the distribution and productivity of the wetland plants associated with Saltwater Lagoon and Saltwater Creek.

Evidence of the pressure on the heath is illustrated by a high incidence of introduced species such as Groundsel and Lantana adjacent to high nutrient areas such as the golf course.

A comparative study of *Baumea articulata* and *Typha orientalis*, two species which occur naturally in close proximity to each other indicated a differing sensitivity to nitrogen and phosphorus loads in sediments. This sensitivity was illustrated in growth, reproduction and productivity with *T orientalis* increasing productivity with high nutrient loads and *B articulata* showing less variation in productivity. (Froend et. Al.1994).

Wet heath communities are highly sensitive to high nutrient levels, the sensitivity of other wetland species to high nutrient levels is variable. Increased nutrients associated with urban development are likely to cause a reduction in biodiversity in the wetlands and an increase in weed species.

Periodic Innundation

Wetland species range from those requiring periodically waterlogged soils to those requiring permanent inundation. The sensitivity to water level fluctuations appears to be greatest in young plants. Eg. sensitivity to flooding or periodic inundation especially in seedling stages influences the limits of growth for some species. The level and duration of inundation is found to be a major factor in the survival of the seedlings from a generally flood tolerant Melaleuca species (Denton & Gnaf 1994). It is likely that *Melaleuca quinquenervia* would exhibit a similar sensitivity.

Studies indicating a re-allocation of biomass between stems and roots of both *Baumea arthrophylla* and *Triglochin procerum* in response to inundation levels indicates that *B arthrophylla* is more suited to seasonal fluctuation than permanent inundation. (Rea et al. 1994). These species which occur naturally in close proximity to each other have differing sensitivity to inundation, and would be expected to respond differently to different inundation regimes.

The comparative study of *Baumea articulata* and *Typha orientalis*, indicated these species have differing sensitivity to inundation level and length. Productivity, phenology (ramet emergence, new leaf growth, flowering and seed production) was influenced by water depth with highest productivity in the mid range inundation regimes. (Froend et. Al.1994).

Seed dispersal, germination and establishment is also dependent on inundation patterns. Trials on seasonal germination from seed banks from new-england tableland wetlands found marked seasonal variation in germination rates with lowest germination in summer. Tableland wetlands experience unpredictable non-seasonal fluctuations in water level with summer conditions being the harshest for seedling survival. (Britton et.al 1994) Although coastal wetlands are exposed to less seasonal variation than tableland wetlands, they do experience un-predictable fluctuations in water level and would be expected to show a similar pattern of low germination in summer.

The function of seasonal and erratic fluctuations in water levels in maintaining wetlands is currently only partly understood. The greatest floristic diversity is found in wetlands with the greatest seasonal fluctuations. Shallow wetlands with a low topographic relief and wide wet-dry ecotones are generally more diverse than deep wetlands. Fluctuations in the water levels help maintain floristic diversity, although wetland plants can generally survive a variety of wetness regimes for extended periods, each species requires different conditions to germinate, establish and compete favorably. A more constant water regime would be advantageous to fewer species resulting in a lower floristic diversity. (Brock 1994)

Wetland species are both dependent on and sensitive to water level fluctuations. This sensitivity is complex and varies between seasons, life stages and species. In the long term reduction of the natural fluctuations in water level throughout the wetland communities through berm management is likely to alter the floristic composition and reduce the overall biodiversity of the wetland communities.

Watertable Levels

High Watertable

Most wetland associations are dependent on the watertable being at or near the ground surface (high). Many of the species common in these associations have shallow roots and are relatively intolerant of drying out, other species with deeper roots require a waterlogged substrate to be able to absorb nutrients.

Periodically High Watertable

The wet heath associations are dependant on a periodically high watertable. Wet heath generally grows in conditions of low moisture and soil fertility, these conditions contribute to high biodiversity normally associated with these communities. Periodically wet heaths require the water table rise to near the surface so that moisture and nutrients such a phosphorus and nitrogen become available to the plants, however extended periods of high water table levels are detrimental to the native heath plants and would cause the long term degradation of these communities.

Reduction of the natural fluctuations in water table level through berm management is likely to degrade the wet heath and reduce the overall biodiversity of the other wetland

communities.

Wetland Boundaries

Wetlands are areas with low relief and small vertical change in the water height may have extensive horizontal impact, a broad zone of uncertainty of species distribution or ecotone will result. These ecotone or boundary areas change over time in response to longer term fluctuations or drought / flood cycles. A natural wetland needs to be able to respond to these fluctuations, and wetlands adjoining residential development require a suitable buffer to enable this. Winning et. Al. (2000) found that wetland species can occur in quadrats as dominants or co-dominants at least up to 100m beyond a ground surveyed wetland boundary. In the saltwater catchment significant proportions of wetland species were located several hundred metres from the wetland boundary especially in areas where topographic relief is low. A wetland buffer should be considered in vertical rather than horizontal terms and should be wide enough to encompass the total wetland. In areas of low topographical relief the wetland buffer should be reasonably wide to be effective.

The transects surveyed by DLWC illustrate the low topographical relief over some parts of the catchment. Transect DD indicates a rise of about 1.5 metres was measured from the edge of the Melaleucas to the western end of the transect, disturbed wet heath occurs along the majority of the transect. The southern end of transect BB shows a very low topographical relief with less than 1 metre rise between the lagoon edge and the start of the eucalypt community.

Ecologically the Saltwater lagoon wetland ecosystem includes all of the associations listed in table 3, it would also have included the low lying residential areas such as the area to the east of Mitchell Street and parts of the golf course. The current ecological boundary of the wetland includes all the associations dependant on high watertable, periodic flooding or periodically high watertable, these areas represent 177 ha or 19.7 % of the catchment. and are indicated by the blue boundary on map 3. The SEPP14 boundary is also shown, the SEPP14 area covers 104 ha or 12% of the catchment. The majority of the SEPP14 area is reserved within Hat Head National Park.

Map 3 illustrates the extent of wetland and watertable dependent communities, the gazetted SEPP14 boundary and the national park boundary. Ideally this entire area within the blue boundary should be included in the wetland buffer, with the preferred landuse allowing for the retention of the wet heath, current landuse has degraded but not destroyed the wet heath associations. The retention of the entire area in a natural state is unlikely to be achieved, however the potential impact of the land use on the area on the remaining wetland should be considered, the currently proposed tea-tree growing landuse is likely to be far less detrimental to the long term survival of the wetland than urban development.

A wetland buffer should be considered in vertical rather than horizontal terms and should be wide enough to encompass all of the wetland and watertable dependent communities (as indicated in map3). In areas of low topographical relief the wetland buffer will need to be a considerable width.

Conservation Values of Vegetation Communities Occurring within the Catchment

Table 4 Vegetation Associations Extent and Conservation Priority

Association No	Association name	Ha in Hat Head	Ha in catchment	% of catchment	Ranking Conservation Priority *
0503	Lophostemon confertus LRF	27	1.4	12.8	1
3002/3504	Lophostemon confertus – Eucalyptus pilularis WSF	52	28	3.1	3
3504	Eucalyptus pilularis DSF	285	167.2	18.6	4
3516	Eucalyptus signata DSF	10	19.2	2.1	5
3515	Eucalyptus planchoniana DSF	5	18.3	1	1
3529	Eucalyptus pilularis – C intermedia DSF	195	48.8	5.4	4
3550	Eucalyptus pilularis – E gummifera/ E planchoniana DSF	991	2.5	0.2	5
3553	Allocasuarina littoralis – Jacksonia scoparia/Banksia integrifolia DSF	55	0.83	0.1	1
3554	Eucalyptus pilularis – E signata DSF	14	37.3	4.1	5
4002	Eucalyptus robusta SSF	32	2.7	0.3	4
4003	Melaleuca quinquenervia SSF	929	70	7.7	2
4099	Casuarina glauca - Melaleuca quinquenervia SSF	136	5.6	0.6	2
5007	Eucalyptus pilularis/ E planchonana/ E gummifera shrubland	247	11.7	1.2	3
5401	Undetermined Heath		3.6	0.4	2
5408	Acacia sophorae shrubland	6	10.3	1.5	3
5503	Banksia ericifolia shrubland	23	17.8	1.9	3
6000/6400	wet heath/ sedgeland		4.5	0.5	3
6002	B oblongifolia L liversidgei Lepyrodia	394	12.3	1.4	2

Association No	Association name	Ha in Hat Head	Ha in catchment	% of catchment	Ranking Conservation Priority *
	interupta Sprengelia sprengelioides X fulva heath				
6003	Leptospernum juniperinum heath	0	2.7	0.3	2
6202	Spinifex sericeus tussock grassland	3	5.6	0.6	1
6400	Undetermined sedgeland		0.6	0.1	2
6402	Baumea juncea sedgeland	71	20.4	2.3	1
6403	Leptocarpus tenax Restio pallens Schoenus brevifolius sedgeland	135	3.5	0.4	1
6502	Juncus krausii rushland	0	0.6	0.1	1
9010	Foredune complex	137	43.2	1.8	2

*** The conservation priority ranking has been assigned by Kendall is based on the Griffiths and CRA targets, and is intended as a guide to the relative conservation value 1 is the highest, this ranking is general and does not consider the condition of individual areas.**

Fauna habitats in the study area

The vegetation descriptions provided above provide a basis for describing fauna habitats on the study area.

The dry and wet sclerophyll forest communities have been also assessed structurally
The various vegetation communities may be amalgamated to provide a list of fauna habitats present on the study area. These fauna habitats are:

- Banksia – foredune complex, coastal banksia dry heath shrubland;
- Rainforest;
- Dry Sclerophyll Forest - blackbutt, scribbly gum, needlebark stringybark;
- Wet Sclerophyll Forest – flooded gum, blackbutt, brushbox;
- Wet heath;
- Wet and dry sclerophyll forest with high senescence;
- Melaleuca and Melaleuca/ Casuarina swamp sclerophyll forest and woodland;
- Sedgeland;
- Rushland;
- Open water; and,
- Beach.

The fauna habitats listed above are illustrated on Map 2.

Fauna of conservation significance recorded on the NSW NPWS Atlas within 10kms of Saltwater lagoon

Table 5: TSC Act threatened species

Common Name	Scientific Name	Status	Habitat
Osprey	Pandion haliaetus	V	Forages over variety of aquatic habitats Higgins & Davies (1996)
Rose-crowned Fruit-Dove	Ptilinopus regina	V	Forest
Wompoo Fruit-Dove	Ptilinopus magnificus	V	Forest
Square-tailed Kite	Lophoictinia isura	V	Forest
Powerful Owl	Ninox strenua	V	Forest
Glossy Black-Cockatoo	Calyptorhynchus lathami	V	Forest
Barred Cuckoo-shrike	Coracina lineata	V	Forest
Brush-tailed Phascogale	Phascogale tapoatafa	V	Forest
Squirrel Glider	Petaurus norfolcensis	V	Forest
Koala	Phascolarctos cinereus	V	Forest
Grey-headed Flying-fox	Pteropus poliocephalus	V	Forest
Common Blossom-bat	Syconycteris australis	V	Forest
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	V	Forest
Eastern Freetail-bat	Mormopterus norfolkensis	V	Forest
Common Bentwing-bat	Miniopterus schreibersii	V	Forest
Little Bentwing-bat	Miniopterus australis	V	Forest
Hoary Wattled Bat	Chalinolobus nigrogriseus	V	Forest
Greater Broad-nosed Bat	Scoteanax rueppellii	V	Forest
Black-necked Stork	Ephippiorhynchus asiaticus	E1	Fresh/Brackish Higgins & Davies (1996)
Comb-crested Jacana	Irediparra gallinacea	V	Freshwater swamps with floating vegetation Higgins & Davies (1996)
Wallum Froglet	Crinia tinnula	V	Freshwater wetlands Higgins & Davies (1996)
Little Tern	Sterna albifrons	E1	Includes beaches for nesting Higgins & Davies (1996)
Pied Oystercatcher	Haematopus longirostris	V	Includes intertidal mudflats Marchant & Higgins (1993)
Black-tailed Godwit	Limosa limosa	V	Mainly intertidal areas Higgins & Davies (1996)
Sooty Oystercatcher	Haematopus fuliginosus	V	Strickly marine coastal usually within 50 m of shore Marchant & Higgins (1993)

Common Name	Scientific Name	Status	Habitat
Magpie Goose	Anseranas semipalmata	V	Variety of wetlands Marchant & Higgins (1990)

Table 6: International migratory bird agreement species (Jamba/Chamba)

Common Name	Scientific Name	Status	Habitat
Little Tern	Sterna albifrons	E1	Includes beaches for nesting Higgins & Davies (1996)
Ruddy Turnstone	Arenaria interpres	P	Mostly on coastal shoreline where it forages in seaweed Higgins & Davies (1996)
Sooty Oystercatcher	Haematopus fuliginosus	V	Strickly marine coastal usually within 50 m of shore Marchant & Higgins (1993)
Eastern Curlew	Numenius madagascariensis	P	intertidal mudflats Higgins & Davies (1996)
Whimbrel	Numenius phaeopus	P	intertidal mudflats Higgins & Davies (1996)
Black-tailed Godwit	Limosa limosa	V	Mainly intertidal areas Higgins & Davies (1996)
Bar-tailed Godwit	Limosa lapponica	P	Mainly intertidal areas Higgins & Davies (1996)
Grey-tailed Tattler	Heteroscelus brevipes	P	Includes intertidal mudflats Higgins & Davies (1996)
Common Sandpiper	Actitis hypoleucos	P	Wetlands of varying levels of salinity with muddy margins Higgins & Davies (1996)
Common Greenshank	Tringa nebularia	P	Includes swamps with mud flats Higgins & Davies (1996)
Marsh Sandpiper	Tringa stagnatilis	P	Wetlands of varying levels of salinity with muddy margins
Sharp-tailed Sandpiper	Calidris acuminata	P	Muddy edges of fresh or brackish wetlands Higgins & Davies (1996)
Latham's Snipe	Gallinago hardwickii	P	Prefers open freshwater wetlands Higgins & Davies (1996)
Intermediate Egret	Ardea intermedia	P	Variety of wetlands Marchant & Higgins (1990)
Great Egret	Ardea alba	P	Wide variety of wetlands Marchant & Higgins (1990)
Eastern Reef Egret	Egretta sacra	P	Prefers rocky shorelines Marchant & Higgins (1990)
White-bellied Sea-Eagle	Haliaeetus leucogaster	P	Forages over variety of aquatic habitats Higgins & Davies (1996)
Brahminy Kite	Haliastur indus	P	Forages over variety of aquatic habitats Higgins & Davies (1996)

Common Name	Scientific Name	Status	Habitat
Osprey	Pandion haliaetus	V	Forages over variety of aquatic habitats Higgins & Davies (1996)
Rainbow Bee-eater	Merops ornatus	P	Forest
Common Redshank	Tringa totanus	P	Includes swamps with mud flats Higgins & Davies (1996)
Cattle Egret	Ardea ibis	P	Wide variety of swampy and grassy areas Marchant & Higgins (1990)

Table 7: Other EPBC Act species

Common Name	Scientific Name	Status	Habitat
Little Tern	Sterna albifrons	E1	Includes beaches for nesting Higgins & Davies (1996)
Latham's Snipe	Gallinago hardwickii	P	Prefers open freshwater wetlands Higgins & Davies (1996)
Black-necked Stork	Ephippiorhynchus asiaticus	E1	Fresh/Brackish Higgins & Davies (1996)
White-bellied Sea-Eagle	Haliaeetus leucogaster	P	Forages over variety of aquatic habitats Higgins & Davies (1996)
White-throated Needletail	Hirundapus caudacutus	P	Forest
Rufous Fantail	Rhipidura rufifrons	P	Forest
Black-faced Monarch	Monarcha melanopsis	P	Forest
Spectacled Monarch	Monarcha trivirgatus	P	Forest
Grey-headed Flying-fox	Pteropus poliocephalus	V	Forest

4 Discussion

Weeds

The following weed species occur in the study area and are considered to be a threat to native vegetation.

Bitou bush *(Chrysanthemoides monilifera)*
Potentially a major problem in communities such as coastal scrub and banksia woodland, where it can suppress and compete against native species.

Control is essential to maintain the existence of coastal banksia communities and the control programs particularly on the fore dune should be maintained.

Bitou also occurs in casuarina, paperbark and eucalypt forests, but growth is slower. As it is not yet known to what extent it is a problem in these forests, further observation is required.

Groundsel bush *(Baccharis halimifolia)*
Groundsel bush is a hardy deep-rooted tree capable of eventually forming closed thickets excluding all other plant species. The seed has a pappus of hairs enabling efficient wind dispersal, although most seed falls near the parent plant the seeds can travel long distances.

The wet heath areas to the east of the golf course and surrounding the sewrage treatment works are currently most affected. However, groundsel is likely to become a major problem in the wet heath, paperbark and swamp mahogany swamp forests of the area. Prompt control is strongly recommended.

Glory lily *(Gloriosa superba)*
Glory lily was detected on the fore dune in the study area. The current infestation appears to be minor however the dry weather may have delayed emergence from the underground tuber of this years shoots.
Glory lily has red and black seeds that are very attractive to birds and dispersal appears to be associated with dispersal of bitou bush. This species requires deep sandy soil for the tuber growth and is likely to be confined to the dune areas. Control should be undertaken in association with bitou bush and asparagus fern. Physical removal of plants and their tubers should be undertaken to limit the expansion of the existing population into new areas. (Note that the species contains toxic alkaloids potentially fatal to humans.)

Asparagus fern *(Protasparagus aethiopicus)*
Asparagus fern occurs at low densities on the fore dune area. It has fleshy red fruits that are dispersed by birds. Although it currently represents a minor problem it could be controlled in association with bitou bush and glory lily.

Running Bamboo (Species unknown)
A small patch of running bamboo occurs on the northern end of the wet heath adjacent to the urban area. Eventhough it is only spreading vegetatively, the area of infestation will continue to increase exponentially.

Coral Tree (*Erythrina x sykseii*)
Coral trees are the dominant species in both the areas mapped as introduced trees. Coral trees have been widely planted as shade trees. These trees generally spread from cuttings and are unlikely to spread, they do however grow into large trees that suppress native vegetation.

Pine (Pinus radiata)
Mature Pines along the eastern edge of the golf course are producing numerous seedlings in the adjacent wet heath communities. These pines will continue to spread while the parent trees are producing seed.

Lantana *(L. camara)*
Lantana is widespread throughout the study area. It is a major problem on forest edges, and in native vegetation communities subject to major disturbance. This species restricts human movement and although it is a species that is well established as part of the landscape control may be required along pathways and other human use areas.

Camphor Laurel *(Cinnemon camphora)*
Camphor laurel seedlings were detected throughout the wet and dry sclerophyll communities within the study area. The distribution is very sparse and all of the plants located were immature.

Camphor laurel seeds are effectively dispersed by birds and animals. This species which suppresses the growth of competitors is capable of becoming a major environmental weed, as such this species should be monitored and removed.

Mile-a-minute or Coast Morning Glory (*Ipomoea cairica*)
Coast morning glory was recorded in the fore dune area particularly near the creek entrance. This species is capable of very rapid growth and smothers native vegetation and is capable of creeping along the ground as well as twining through trees. This species can cause loss of flora biodiversity and habitat values.

Land Clearing

Extensive clearing and slashing of the wet heath is currently being undertaken, the wet heath associations mapped in the study area are recognised as a regionally vulnerable. The conservation target for wet heath of 60% of the area extant in 1999 has not been reached in the regional reserves. The wet heath associations to the east of the saltwater lagoon have been recently slashed and/or burnt, however they continue to exhibit a reasonably high floristic diversity and contain low levels of weed infestation, as such have high flora and habitat conservation value. Even though wet heath is not included in the SEPP14 definition it contains elements of a wetland community and forms an integral part of the wetland ecosystem.

Clearing of small isolated pockets of Melaleuca quinquenervia dominated swamp sclerophyll forest has also been undertaken to the west and south of the Lagoon.

Sewerage Treatment Works

The sewerage treatment works is located in the catchment, it does not discharge into the catchment, however heavy weed infestations in the vicinity of the sewerage treatment works were observed and may indicate elevated nutrient loads in the vecinity.

Golf Course

The golf course adjoins the wet heath, golf courses are potential sources of nutrient contamination, with the use of fertalisers for their maintenance the high incidence of weed species such as groundsel, lantana and pines invading the wet heath are indicative of elevated nutrient loads.

Fire

Fire frequency in Hat Head National park is high, with most of these being unplanned wildfires, frequent hot fires have and are likely to continue to degrade the native vegetation. Areas of native vegetation isolated from the national park, as are some areas of native vegetation within the Saltwater Creek and Lagoon catchment, are often burnt in different fire events and can provide important refuge for fauna species. A reduction in moisture in the catchment as a result of berm management is likely to increase the areas potential to carry wildfire.

Fauna

The following fauna habitats identified on Map 2 are considered as susceptible to impact from changes to the hydrological regime created by opening of the berm:

- Swamp Sclerophyll Forest and Woodland;

- Open Water;
- Sedgeland;
- Rushland; and,
- Wet Heathland

Impacts on Fauna Habitats

As identified above the opening of the berm could directly impact on a number of identified fauna habitats. However indirect impacts to fauna dependant on other habitats that occur in the catchment and locality could occur due to the degradation of the potential foraging resources that the habitats that may be directly impacted upon provide for those species.

Degradation of the Swamp Sclerophyll Forest and Woodland could impact on the nectar resource that this habitat provides. Therefore a number of TSC Act threatened species could be affected including the potentially occurring Swift Parrot, Regent Honey-eater, Queensland Blossom Bat and Grey-headed Flying-Fox. The Queensland Blossom Bat may also use this habitat as a sheltering resource. Degradation of the sedges that occurs in some areas as ground cover could impact on a range of species as described below. Likewise degradation of the rain-forest elements in the this habitat could impact on TSC Act threatened species such as the Wompoo Fruit-Dove.

Degradation of the Wet Heath habitat could impact on a number of potentially occurring TSC Act threatened species including the Eastern Chestnut Mouse and the Queensland Blossom Bat.

Opening of the berm and subsequent partial draining of the lagoon could impact on a range of species that use the open water and sedgelend as foraging, sheltering and nesting habitat. Microbats including a number of potentially occurring TSC Act threatened species which may use the lagoon as a foraging resource could be impacted. Waterbirds including waders as ducks, grebes, snipes, herons, stilts, egrets, storks swans and more could be impacted. These species would include a number of threatened species and species covered by international migratory agreements (Jamba & Chamba). Note however that most of the threatened species and species covered by Jamba & Chamba are not likely to breed on or near the lagoon or creek, the exception being the Black Bittern which has been recorded breeding on the coast of north-east NSW. Information on the breeding of a range of waterbirds is provided in Table 8. Table 8 indicates that a number of the more common waterbirds are known to breed on the northeast NSW coast in habitats similar to those that occur in the sedgeland and on the lagoon therefore there could be an impact on the areas biodiversity. During drought periods many of the waterbirds which usually reside in the wetlands of inland areas of Australia move to the coast to seek refuge in coastal wetlands. Opening of the berm would be expected to have an impact on the value of the lagoon as a drought refuge for these species.

Opening of the berm may result in Saltwater lagoon becoming more saline and tidal influences may be apparent. The tidal influences could create tidal mud flats. It is considered that these impacts could detract from the habitat value of the rushland and sedgeland for bird species who have a preference for freshwater habitats. See above tables. The tidal influence could increase the habitat value of the lagoon edge for those bird species that have preference for tidal mudflats or more saline conditions. It is not known to what level this

increase could be it may even be negligible and it may take a substantial period of time to develop depending upon the time it takes for prey species to colonise the mudflats.

Table 8: Waterfowl Breeding Seasons and Nesting Requirements

Common Name	Scientific Name	Breeding Season *	Core Breeding Season *	NE NSW (1)	Nesting	Status TSC Act	JAMBA - CHAMBA	CRA Priority
Lewins Rail	*Dryolimnas pectoralis*	August to January	September to November	No	Nest of grass or rushes in dense ground vegetation	P	-	Y
Buff-banded Rail	*Gallirallus philippensis*	All year	March to May & August to December	Yes	Nest of grass or rushes in dense ground vegetation	P	-	
Australian Crake	*Porzana fluminea*	July to March	August to January	No	Nest of grass on ground near water	P	-	
Baillon's Crake	*Porzana pusilla*	All year	August to April	No	Nest of leaves in reeds near water	P	-	
Spotless Crake	*Porzana tabuensis*	August to March	August to January	No	Nest of leaves in reeds near water	P	-	
Bush-hen	*Amaurornis olivaceus*	October to March	November to February	No	Nest ofgrassnear ground	V	-	Y
Dusky Moorhen	*Gallinula tenebrosa*	All year	All year	Yes	Platform of vegetation amoung rushes	P	-	
Purple Swamphen	*Porphyrio porphyrio*	All year	All year	Yes	Platform of reeds	P	-	
Eurasian Coot	*Fulica atra*	All year	All year	Yes	Nest of sticks or twigs near water orfloating	P	-	
Great Crested Grebe	*Podiceps cristatus*	October to February	November to January	No	Mat of water plants on ground near water	P	-	
Australasian Grebe	*Tachybaptus novaehollandiae*	September to May	October to April	Yes	Nest of floating plant material usually on small water body	P	-	

Common Name	Scientific Name	Breeding Season *	Core Breeding Season *	NE NSW (1)	Nesting	Status TSC Act	JAMBA - CHAMBA	CRA Priority
Hoary-headed Grebe	*Poliocephalus poliocephalus*	September to May	October to April	No	Raft of water plants	P	-	
Great Cormorant	*Phalacrocorax carbo*	All year	October to June	Yes	Nest of sticks in tree	P	-	
Little Black Cormorant	*Phalacrocorax sulcirostris*	All year	September to December & February to May	Yes	Nest of sticks in tree	P	-	
Pied Cormorant	*Phalacrocorax varius*	All year	December to July	Yes	Nest of sticks	P	-	
Little Pied Cormorant	*Phalacrocorax melanoleucos*	All year	September to April	Yes	Nest of sticks in tree	P	-	
Darter	*Anhinga melanogaster*	All year	July to April	Yes	Nest of sticks in tree	P	-	
Australian Pelican	*Pelecanus conspicillatus*	All year	All year	Yes	in bushes	P	-	
Black-winged Stilt	*Himantopus himantopus*	All year	August to January	Yes	Depression in mud near water or built up structure in shallow water	P	-	
Latham's Snipe	*Gallinago hardwickii*	No	No	No		P	-	
Painted Snipe	*Rostratula benghalensis*	All year	September to December	No	Slight depression in mud surrounded by shallow water	P	Y	
Comb-crested Jacana	*Irediparra gallinacea*	October to January	November to May	Yes	A raft of sedges on floating vegetation	V	-	
Brolga	*Grus rubicundus*	All year	September to May	Yes	Nest a platform of dry grasses or sedge beside swampy grasslands	V	-	

Common Name	Scientific Name	Breeding Season *	Core Breeding Season *	NE NSW (1)	Nesting	Status TSC Act	JAMBA - CHAMBA	CRA Priority
Glossy Ibis	*Plegadis falcinellus*	All year	February to May & September to December	No	Nest of sticks in tree	P	-	
Sacred Ibis	*Threskiornis molucca*	All year	February to May & August to December	No	Sticks on low plants	P	-	
Royal Spoonbill	*Platalea regia*	All year	February to May & July to November	Yes	Nest of sticks in tree	P	-	
Yellow-billed Spoonbill	*Platalea flavipes*	All year	March to May & August to November	No	Nest of sticks in tree	P	-	
Black-necked Stork	*Ephippiorhynchus asiaticus*	February to September	March to July	Yes	Large stick platform in a tree	E	-	
Little Egret	*Egretta garzetta*	All year	February to May & October to December	Yes	Nest of sticks in tree	P	Y	
Intermediate Egret	*Ardea intermedia*	All year	October to May	Yes	Nest of sticks in tree	P	Y	
Great Egret	*Ardea alba*	All year	October to May	Yes	Nest of sticks in tree	P	Y	
White-faced Heron	*Ardea novaehollandiae*	August to March	September to January	Yes	Nest of sticks in tree	P	-	
Pacific Heron	*Ardea pacifica*	August to March	September to February	Yes	Nest of sticks in tree	P	-	
Black Bittern	*Ixobrychus flavicollus*	August to March	September to January	Yes	Nest of sticks in tree	V	-	Y
Australasian Bittern	*Botaurus poicilopiilus*	July to March	September to January	No	Trampled reeds and rushes over water	V	-	
Black Swan	*Cygnus atratus*	All year	February to September	Yes	A mound of vegetation built on reeds or small island	P	-	

Common Name	Scientific Name	Breeding Season *	Core Breeding Season *	NE NSW (1)	Nesting	Status TSC Act	JAMBA - CHAMBA	CRA Priority
Pacific Black Duck	*Anas superciliosa*	All year	March to October	Yes	In long grass rushes	P	-	
Chestnut Teal	*Anas castanea*	All year	July to November	Yes	In long grass rushes	P	-	
Grey Teal	*Anas gracilis*	All year	All year	Yes	Nest almost anywhere very opportunistic	P	-	
Hardhead	*Aythya australis*	September to June	October to May	Yes	Woven reeds sedges and sticks	P	-	

* = Simpson & Day 1994 breeding season would vary according to distributional range of species

(1) = Breeding records on coast of NE NSW Blakers et al 1984

Berm Management

Flora

Saltwater Creek and Lagoon appears to be a generally closed hydrological system that is intermittently open. The catchment contains a variety of wetland associations with a high species diversity. The wetland species have varying sensitivity to inundation levels and nutrient loads. Management of the berm will reduce the seasonal and unpredicted fluctuations in water level, this is likely to reduce flora species diversity and affect species distribution patterns, some species would become more widespread others less widespread. The magnitude and significance of the impact resulting from berm management is difficult to determine, with the limited understanding of the impact of water level fluctuations on wetlands.

Wetlands experience natural fluctuations in water levels and wetland species are both dependent on and sensitive to these fluctuations. This sensitivity is complex and varies between seasons, life stages and species. An isolated berm opening event is unlikely to cause significant impact on the wetlands however the long-term impact of reducing the magnitude of fluctuations in water and watertable level by berm management may cause significant impact on wetland and watertable dependent flora species or associations. The magnitude of this impact, however is difficult to determine, especially when other influences such as sea level rise, increased nutrient loads and urban development are also occurring.

4 Recommendations

The following recommendations are made as a result of this assessment of the study area. The Saltwater creek, lagoon and their catchment represents a sensitive coastal ecosystem containing conflicting and currently incompatible land use.

Nutrient Contamination

The potential for nutrient contamination from urban development is high, this system is an essentially a closed system containing a large area of wetland vegetation associations, some of which have a high sensitivity to increased nutrients. Degradation of the wetland and wet heath associations from nutrient contamination is likely. It is recommended that management to reduce nutrient contamination is undertaken eg, upgrade stormwater management, reduce lawn and garden fertiliser in the catchment.

Wet Heath

All of the wet heath associations mapped in the study area are recognised as a regionally vulnerable. The wet heath associations to the west of the saltwater lagoon have been recently slashed and/or burnt, however they continue to exhibit a reasonably high floristic diversity as such have potentially high flora and habitat conservation value. Management of this area should consider the conservation values of the mosaic of wet heat communities.

Weeds

Many of the weeds located within the study area have the potential to drastically reduce biodiversity and impact on the floristic and habitat values of the area, these weeds need to be controlled.

Wetland Boundary and Buffer

Wetland conservation and urban development are conflicting land uses that require an effective buffer. The wetland buffer should be considered in vertical rather than horizontal terms and should be wide enough to encompass all of the wetland and watertable dependent communities. In areas of low topographical relief the wetland buffer will need to be wide. Wetland protection provided by the SEPP14 and national park does not provide an adequate buffer to ensure the long-term survival of the wetland habitats of saltwater lagoon and creek. Ideally all of the wetland and watertable dependent associations outside the current SEPP and national park boundaries should be managed in a natural state as a buffer. The retention of the entire area in a natural state is probably unrealistic and any proposed land use for these areas will require careful consideration and management. Kendall considers in this area a buffer of 1 to 1.5 metres vertical height above the upper reaches of the wetland communities identified as dependent on periodic flooding and high watertable in Map3 is likely to accommodate the majority of the temporal and seasonal fluctuations in wetland boundaries.

Berm Management

Wetland species are both dependent on and sensitive to water level fluctuations. This sensitivity is complex and varies between seasons, life stages and species. In the long term reduction of the natural fluctuations in water level throughout the wetland communities through berm management is likely to significantly alter the floristic composition and reduce the overall biodiversity of the wetland communities.
Other influences such as sea level rise, increased nutrient loads and urban development that are also occurring would make it difficult to determine the magnitude of the impact of berm management.

Fauna

There could be an impact on important species known to occur in the locality.

The level of future impact of possible beneficial habitat value increases for some species is unknown compared to the level of detrimental impact from other important species. Therefore the precautionary principle is applicable.

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6. Maps

Map 1 Saltwater Creek and Lagoon Catchment Vegetation Associations

Prepared from the Hat Head National Park coastal mapping supplemented by aerial photography interpretation of the Nambucca (1997) 1:25 000 and Coastal Survailance (2000) 1:10 000 photography.

Map 2 Saltwater Creek and Lagoon Catchment Fauna Habitats

Prepared from the vegetation association mapping (Map 1)

Map 3 Saltwater Creek and Lagoon Catchment Wetland Boundaries

Prepared from the vegetation association mapping (Map 1)

Map 4 Saltwater Creek and Lagoon Catchment Forest Senescence

Prepared from the CRAFTI structural mapping DUAP (1999) and supplemented by aerial photography interpretation

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